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THE PERFORMANCE ANALYSIS OF EDGE DETECTION ALGORITHMS FOR IMAGE PROCESSING IN PRESENCE OF NOISE

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ABSTRACT

Edge Detection is one of the important and most frequently used approaches for Image Segmentation in Digital Image processing. Selection of particular algorithm for detecting edges of images in presence of noise is always a challenging task. This paper mainly focuses on brief Study of different edge detection algorithms for images in presence of noise. In this paper we have studied Prewitt, Sobel, Robert, and Canny edge detection algorithms to find the better method in image edge detection process finally by comparing the experimental results the canny edge detection algorithm gives better results.

KEYWORDS: Edge Detection, Sobel Operator, Prewitt Operator, Robert Operator & Canny Edge Detector

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Original Article

INTRODUCTION

Image Segmentation is used to extract features of the image which can be split in order to build objects of interest on which analysis can be performed. Edge Detection is one of the most widely used Image Segmentation technique and also a very important area in the field of Image processing. Edge based segmentation exploits spatial information by detecting the edges in an image. Edges are significant changes of intensity in an image and boundaries between segments. Edges are very important portion of the Perceptual information content in an image. Edge detection process includes feature extraction identification of objects in a scene. Therefore edge detection becomes an essential one. In latest research work it becomes an effective field of the Digital Image Processing. There are different types of edge detectors available like, Sobel, Prewitt, Robert, canny edge detector etc. which are briefly explained in the next section. The balance of the paper managed as different types of edge detectors, performance analysis of different edge detectors, experimental results respectively

EDGE DETECTION PROCESS

The Three Fundamental Steps Performed in Edge Detection Process are

- Smoothing of Image for Reduction of noise
- Detection of Edge points
- Localization of Edges in Image

Edge Detection is achieved by different types of edge detectors which are classified in to two categories as shown below

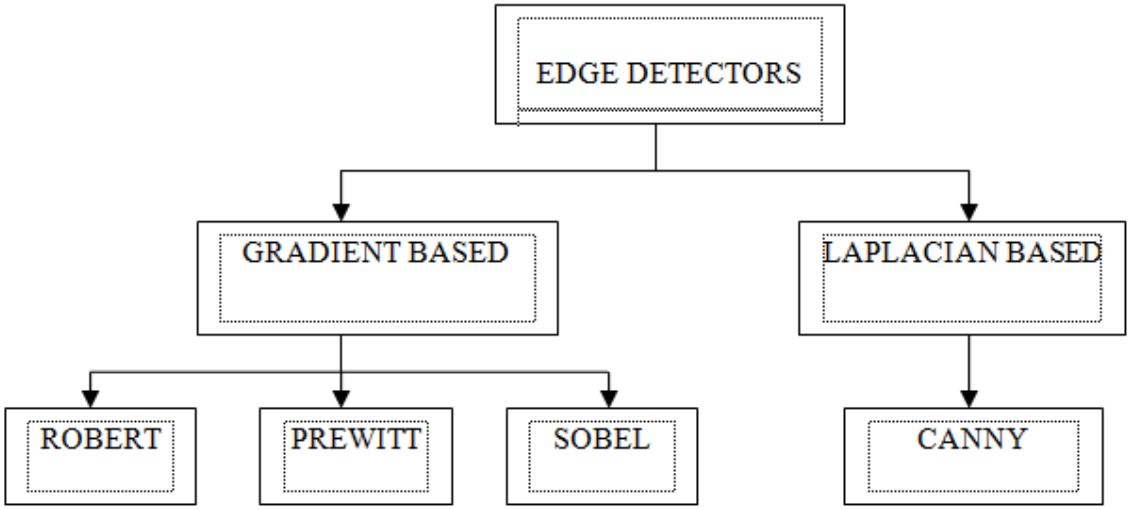


Figure 1

Sobel Operator

Sobel operator is a Gradient based operator. It is used to compare an approximation of the gradient of image intensity function for edge detection. It convolves the kernel with input image to compute magnitude and direction of the gradient. Sobel operator uses two 3x3 kernels represented as Gx and Gy. Gx and Gy are used for horizontal and vertical derivative approximation. The magnitude of the Gradient at each point can be calculated

By |G|= (Gx2 + Gy2)1/2 the direction of the gradient vector given by α=Tan-1 (Gy / Gx) where α is the angle at which maximum rate of change occurs

Sobel edge detector masks given as

Gx

+1	+2	+1
0	0	0
-1	-2	-1

Gy

+1	0	-1
+2	0	-2
+1	0	-1

Prewitt Operator

The two 3x3 kernels Gx and Gy are given as

Gx

+1	+1	+1
0	0	0
-1	-1	-1

Gy

+1	0	-1
+1	0	-1
+1	0	-1

Gy is obtained by rotating Gx by 90^0.compare to Sobel operator It is simpler to implement but it produces noisy results compare to sobel operator.

Robert Operator

The earliest edge detector operator is Robert operator. It is Simpler in implementation compare to Sobel and prewitt edge detector operators. It uses only 2x2 kernel masks to calculate gradient of image highlighting the regions related to edges. Due to having small kernel size it is highly sensitive to noise

The two 2x2 kernels given as

Gx

-1	0
0	-1

Gy

0	-1
+1	0

Canny Edge Detector

It was developed by John. F. Canny in 1986.It was most frequently used edge detection technique in digital image processing. It is a more advanced technique for edge detection with provision made for edge characteristics and noise content.

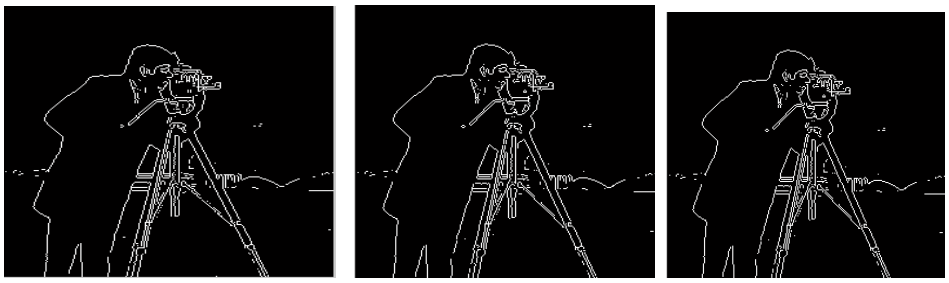
The basic objective of Canny detector is to minimize the error rate, single edge point response and excellent localization of edge points

The Canny detection algorithm executed by first removing the noise from image by passing the image through Gaussian filter then calculating the magnitude and angle of the image gradients next applying non-maxima suppression to the image to thin the edges. Then finally by double tresholding and connectivity analysis to detect and linking edges.

EXPERIMENTAL RESULTS

The work is executed on MATLAB Software with various images. They are gray scale images of size 512x512, identified as cameraman image, MRI image of brain, satellite image. First the different edge detectors mentioned in the previous section are applied to the above images in the absence of noise and then in presence of Salt and pepper noise with 0.05 noise density. In both the case the performance of edge detectors are Analyzed.

Cameraman Image

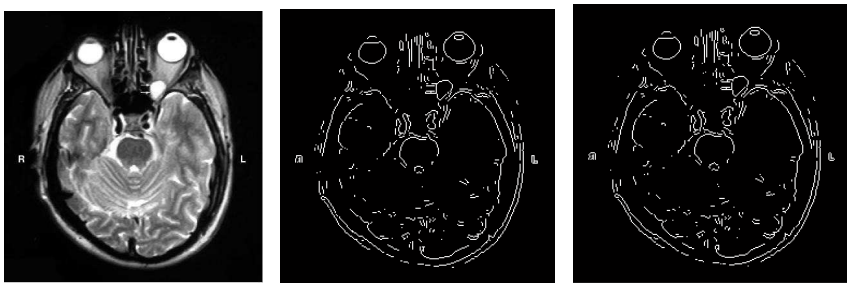


Original Image of Cameraman **Result of Prewitt Operator** **Result of Sobel Operator**

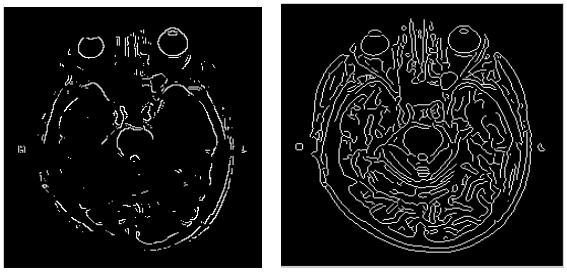
Result of Robert Operator **Result of Canny Operator**

Figure 2: Performance of Prewitt, Sobel, Robert, Canny Edge Detectors on Cameraman Image

Brain MRI Image



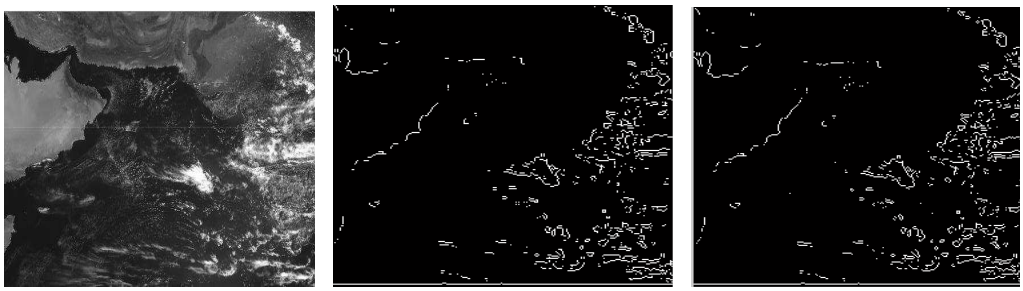
Gray scale Image of Brain **Result of Prewitt Operator** **Result of Sobel Operator**



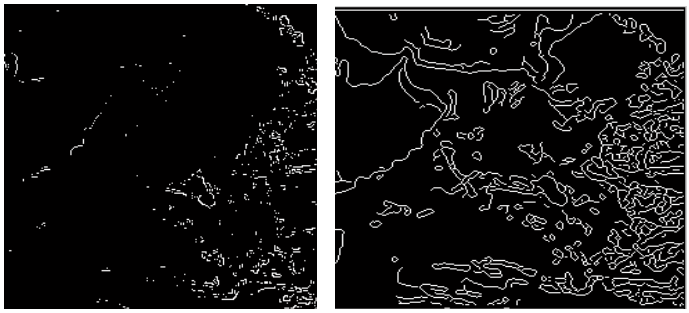
Result of Robert Operator **Result of Canny Operator**

Figure 3: Performance of Prewitt, Sobel, Robert, Canny Edge Detectors on Brain MRI Image

Satellite Image



Gray scale Satellite Image **Result of Prewitt Operator** **Result of Sobel Operator**

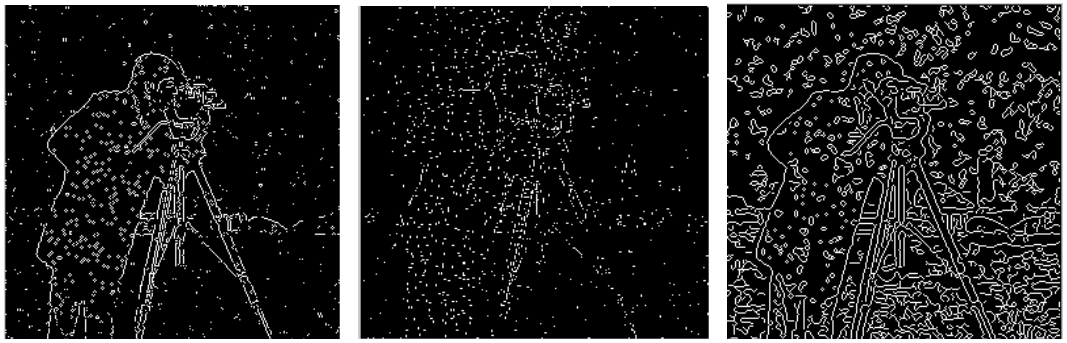


Result of Robert Operator **Result of Canny Operator**

Figure 4: Performance of Prewitt, Sobel, Robert, Canny Edge Detectors on Satellite Image

Cameraman Image in Presence of Noise

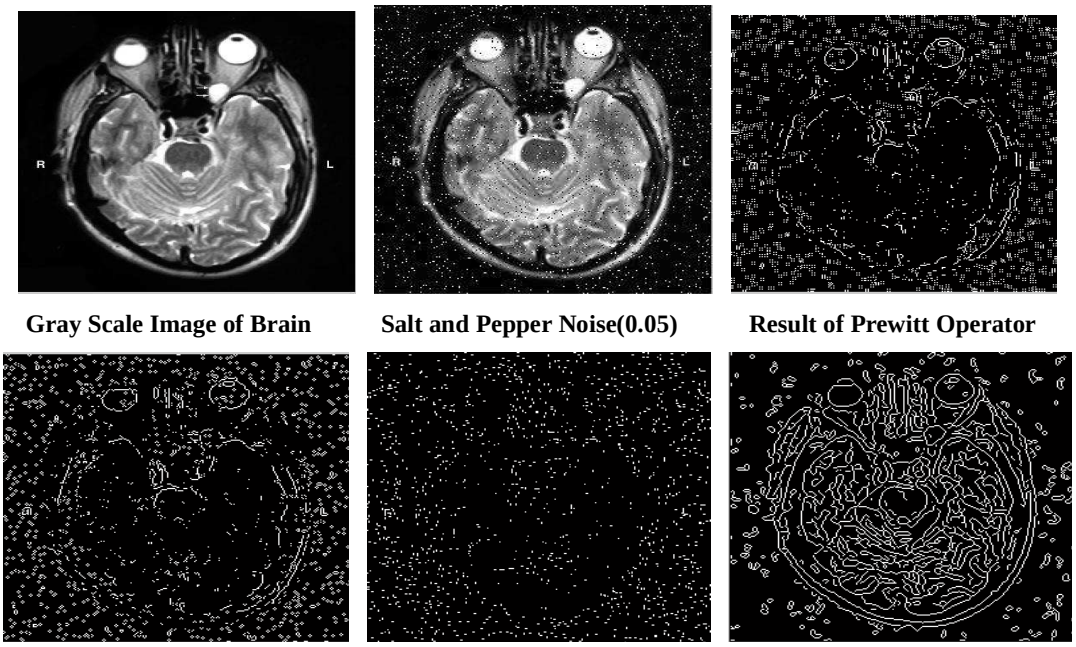
Original Image of Cameraman **Salt and Pepper Noise(0.05)** **Result of Prewitt Operator**



Result of Sobel Operator **Result of Robert Operator** **Result of Canny Operator**

Figure 5: Performance of Prewitt, Sobel, Robert, Canny Edge Detectors on Cameraman Image in Presence of Salt and Pepper Noise with Density of 0.05

Brain MRI Image in Presence of Noise

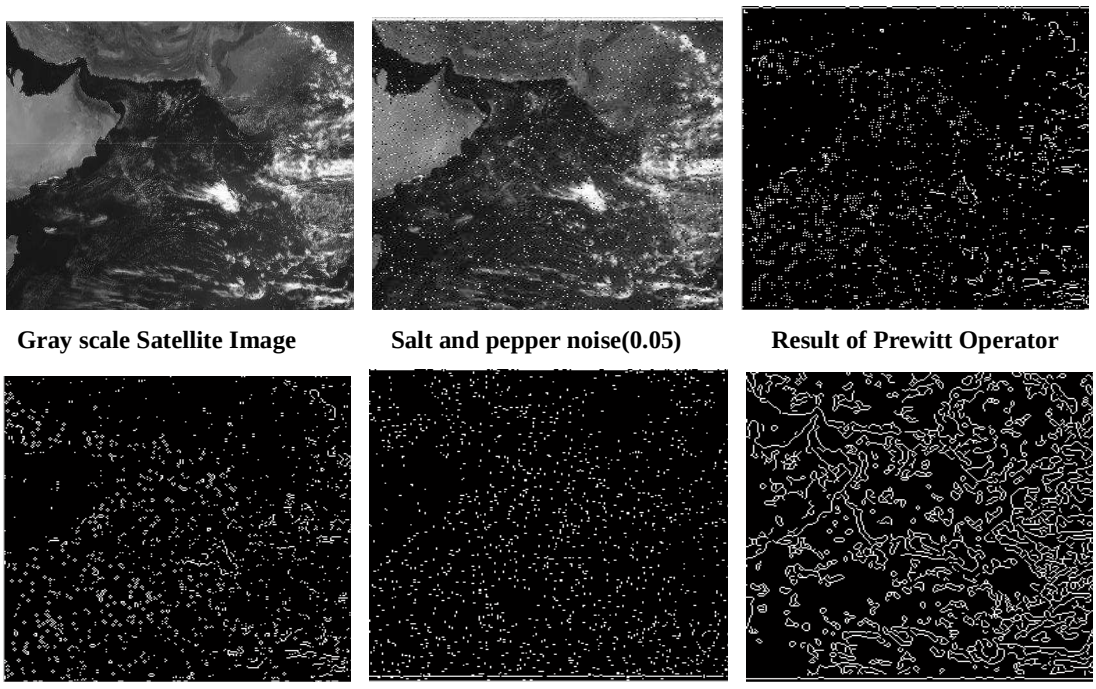


Gray Scale Image of Brain **Salt and Pepper Noise(0.05)** **Result of Prewitt Operator**

Result of Sobel Operator **Result of Robert Operator** **Result of Canny Operator**

Figure 6: Performance of Prewitt, Sobel, Robert, Canny Edge Detectors on Brain MRI Image in Presence of Salt and pepper noise with Density of 0.05

Satellite Image in Presence of Noise



Gray scale Satellite Image **Salt and pepper noise(0.05)** **Result of Prewitt Operator**

Result of Sobel Operator **Result of Robert Operator** **Result of Canny Operator**

Figure 7: Performance of Prewitt, Sobel, Robert, Canny Edge Detectors on Satellite Image in Presence of Salt and Pepper Noise with Density of 0.05

COMPARISON OF DIFFERENT EDGE DETECTORS

Table 1

S.NO	NAME OF THE OPERATOR	ADVANTAGES	DISADVANTAGES
1	CANNY OPERATOR	Excellent performance compare to other operators and Insensitive to noise	Complex method
2	PREWITT AND SOBEL OPERATORS	Simple to implement	Inaccurate sometimes And Sensitive to noise
3	ROBERT OPERATOR	Very simple to implement	Very Inaccurate and more sensitive to noise

CONCLUSIONS

In this Work Different Edge detecting Algorithms are applied on different images in absence and presence of noise. It was clearly observed that Canny edge detection algorithm produce better results compare to Prewitt, Sobel, and Robert Edge detecting operators. Future work focus on extending the algorithms by using advanced methods to improve the results in presence of noise.

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